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United States Department of Agriculture,

BUREAU OF PLANT INDUSTRY,

Farmers' Cooperative Demonstration Work,

WASHINGTON, D. C.

FALL BREAKING AND THE PREPARATION OF THE SEED BED.¹

THE FUNDAMENTAL PRINCIPLES OF GOOD FARMING.

Upon the inauguration of the Farmers' Cooperative Demonstration Work in the Southern States it was found necessary to outline some of the fundamental principles of good farming and to insist that the tillers of the soil should become familiar with them and practice them as a first step in the betterment of farm life. These principles follow:

(1) Prepare a deep and thoroughly pulverized seed bed, well drained; break in the fall to a depth of 8, 10, or 12 inches, according to the soil, with implements that will not bring too much of the subsoil to the surface. (The foregoing depths should be reached gradually if the field is broken with an ordinary turning plow. If a disk plow is used, it is safe to break to the above depths at once.)

(2) Use seed of the best variety, intelligently selected and carefully stored.

(3) In cultivated crops give the rows and the plants in the rows a space suited to the plant, the soil, and the climate.

(4) Use intensive tillage during the growing period of the crops.

(5) Secure a high content of humus in the soil by the use of legumes, barnyard manure, and farm refuse.

(6) Carry out a systematic crop rotation with a winter cover crop on southern farms.

(7) Accomplish more work in a day by using more horse power and better implements.

(8) Increase the farm stock to the extent of utilizing all the coarse food and idle lands of the farm.

(9) Produce all the food required for the men and animals on the farm.

(10) Keep an account of each farm product, in order to know from which the gain or loss arises. (See Farmer's Bulletin 511.)

PREPARATION OF THE SEED BED.

Prepare a deep and thoroughly pulverized seed bed, well drained; break in the fall to a depth of 8, 10, or 12 inches, according to the soil, with implements that will not bring too much of the subsoil to the surface. The foregoing depths should be reached gradually if a field is broken with an ordinary turning plow. If a disk plow is used, it is safe to go to the above depths at once. (See fig. 1.)

It is the purpose of the Farmers' Cooperative Demonstration Work to insist upon such preparation of the soil as will furnish the best feeding grounds for the roots and such as will provide at all times plenty of moisture and food for the growing plants. It is better to secure 10 or 12 inches of well-drained, thoroughly pulverized soil filled with humus than to go deeper at the expense of less thorough preparation.

¹ NOTE.—There is a special circular for the semiarid sections of Oklahoma and Texas which replaces this circular for those sections.

The presence of heat, air, and moisture is essential to chemical and germ action in the preparation of plant food in the soil. The depth to which these penetrate the soil in the South depends upon the depth of the plowing, provided the soil is well drained. There is no use in plowing down into a subsoil full of water.

It has been proved without question that the roots of plants penetrate the soil deeper and feed deeper in deeply plowed land. Thus, in general, it may be stated that when the soil is plowed 3 inches deep the plants have 3 inches of food, when plowed 6 inches deep they have 6 inches of food, and when plowed 10 inches deep they have 10 inches of food. The fact that the bottom portions of the plowed land are not as rich in available plant food as the top portions shows the necessity of getting more air and heat down to them by deeper tillage.

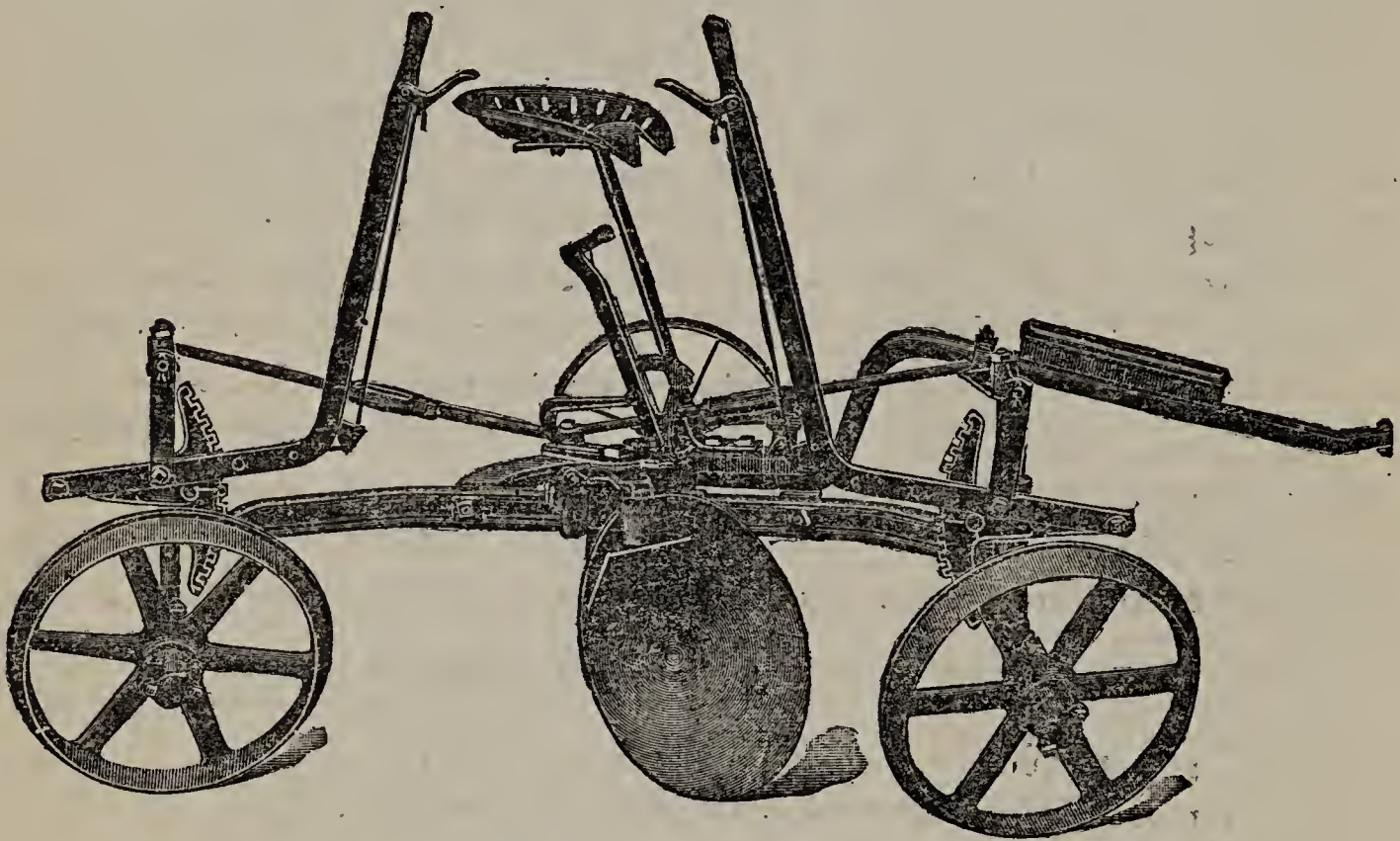


FIG. 1.—A disk plow, an excellent implement for deep fall-breaking.

The soil requirements most essential to plant growth are heat and moisture. Deep breaking insures air and heat at a greater depth.

For plants to do their best there must be in the soil a constant supply of moisture, so that a film of water can envelop the soil particles and absorb nutritive elements. The hair roots of plants drink this for nourishment. If there is any more than enough to serve as films for the soil particles and capillary water, there is too much, and it should be drained off. This can be determined by digging a hole 20 inches deep. If there is standing water in the bottom of the hole, it indicates that there is too much water in the soil or subsoil.

The capacity of a given soil to hold film and capillary moisture depends upon how finely it is pulverized and upon the amount of humus in it. Unplowed lands retain but little water. Thoroughly pulverized soil 3 inches deep can not store enough to make a good crop.

In all Southern States there are every year periods of drought, sometimes not serious, but generally sufficiently protracted to reduce

the crop. The remedy for this is increased storage capacity for moisture. This can be accomplished by deep and thorough tillage and by filling the soil with humus (partly decayed vegetation). The effect of deep tillage has been explained. The effect of humus is to increase greatly the storage capacity of soils for water and to reduce evaporation. A pound of humus will store seven and one-half times as much moisture as a pound of sand, and the sand will lose its water by evaporation three and one-half times more rapidly than the humus. A clay soil will store only about one-fourth as much moisture as humus, and will lose it by evaporation twice as rapidly.

Plants use an enormous quantity of water. An acre of good corn will absorb and evaporate during its growth nearly 10 inches of water. About three-fourths of this amount will be required during the last period of its growth, at the rate of 3 inches of water a month. This is in addition to evaporation from the soil, which, even with the retarding influence of the soil mulch, will amount to several inches each month in midsummer. Land that is plowed only 3 or 4 inches deep, though thoroughly pulverized, will store an amount of moisture entirely insufficient to supply crop requirements in any protracted drought. Shallow and generally poorly prepared seed beds are the principal cause of the low corn yields in the South, and they affect the cotton yields similarly but not so much, because cotton is a more drought-resistant plant than corn. If planting is done at all, it is folly to prepare a seed bed so shallow as to bring about the almost total loss of the crop some years and a reduced crop every year.

THE ROOT SYSTEM OF CORN.

Many farmers plow or cultivate their corn nearly as deeply as they break their land in preparing a seed bed; this leaves no space for roots in the pulverized and aired soil. Roots occupy a large space. If all the roots of a single vigorous cornstalk were placed end to end they would reach more than a mile, and if allowed by the plowing they will fill the soil to a considerable depth and feed in all portions of it. In the principal corn-producing areas of the South the annual rainfall is 35 inches or more, and here in a soil properly prepared for corn the great body of the roots will lie from 3 to 12 inches from the surface and will feed within 2 to 3 inches of the surface if allowed by shallow cultivation.

At the Wisconsin Agricultural Experiment Station it was found that when corn was 3 feet high the roots had penetrated the soil for 2 feet and thoroughly occupied it. At maturity the roots were 4 feet deep, and the upper laterals were about 4 inches from the surface.

At the North Dakota Agricultural Experiment Station the corn roots had penetrated $3\frac{1}{2}$ feet deep and fully occupied the ground ninety days after planting. (See fig. 2.)

At the Minnesota Agricultural Experiment Station the corn roots had penetrated 12 inches deep and had spread laterally 18 inches

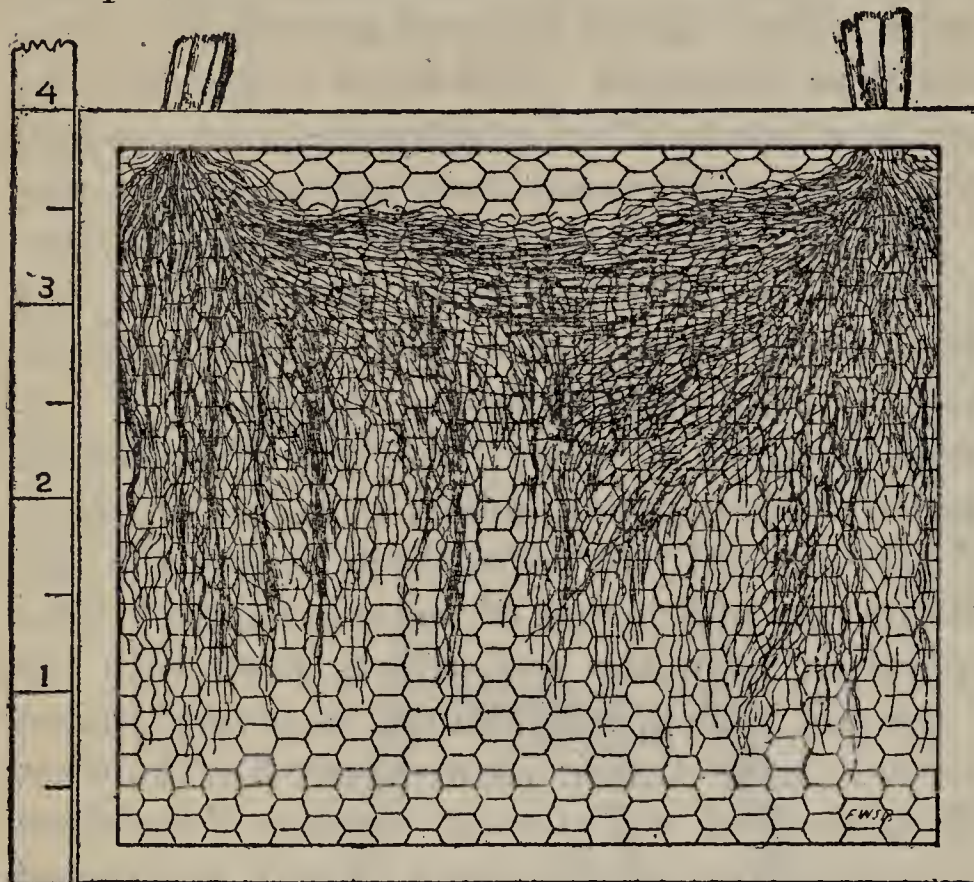


FIG. 2—Distribution of roots of corn at the end of ninety days.
(From Farmers' Bulletin 233.)

eighteen days after planting. In most portions of the South nothing less than an 8-inch seed bed will insure even a fair corn crop, and 10 inches is safer. Some soils may require more. From 6 to 8 inches of preparation for cotton corresponds to 8 and 10 inches for corn, so far as the requirements of the plant are concerned.

WHAT IS DEEP PLOWING?

Plowing 3, 4, 5, or 6 inches deep is only common plowing. In our instructions nothing less than 8 inches is considered "deep" plowing. We are not advocating a single breaking of 8 inches in depth once in two or three years, but the preparation of an 8, 10; or 12 inch seed bed thoroughly pulverized and filled with humus. It is not intended here to insist that this should be done at once in all cases. These are the depths that must be reached finally to secure the best crop results. The farmer must determine how soon he can secure these depths under his conditions.

TIME TO PLOW.

Always plow in the fall before the winter rains set in—the earlier after the first of October the better. Always use a cover crop of oats, barley, wheat, rye, vetch, or crimson clover, if possible. Every observant farmer has noted that seeds germinate more quickly and that plants grow more rapidly on fall breaking than on spring breaking. Fall plowing renders more plant food ready for use, while the preparation of the land in the fall saves work in the spring, when everything on the farm is crowding. A cover crop is a net gain. It keeps the soil from washing, it utilizes the plant food that otherwise might escape into the air, and it adds humus. The soil is improved by the crop, and winter grazing is provided. In plowed land properly handled the loss of plant food is less than

in unplowed land; more plant food may be produced and more can be stored. In case a cover crop is used the loss of plant food is slight.

An objection is sometimes urged that fall-plowed soil becomes saturated with water during the winter and remains wet and cold later in the spring than land left unbroken in the fall. This is true only upon land not sufficiently drained and where the breaking is shallow. Water passes through deep breaking readily, and with reasonable drainage it is ready for planting earlier than lands broken in the spring.

With deep breaking and an abundance of humus it will be possible to dispense with many terraces and yet have no washing of the soil. Terraces are seldom required on the steepest hillsides of the North. Deep freezing opens the soil for the absorption of the rain.

HOW TO DEEPEN THE SOIL.

The advice to go down gradually is given solely because the inexperienced farmer may try to plow too deeply the first time and bring to the surface too much of the subsoil. The best plan is to use the disk plow, so set that it will not bring the subsoil to the surface. Generally it may be sent down 8, 10, or 12 inches with impunity, and, if done in the fall, with slight addition to the cost of shallower breaking. Double plowing—that is, to break at the usual depth and then follow in the same furrow with a narrower plow or a subsoil plow and go down as deep as desired—is better than shallow plowing, though a little more expensive plan than the use of a disk plow and not so effective. Many trials made on a great variety of soils show that the cost of plowing 10 inches deep with a disk plow is on an average about 50 cents per acre more than ordinary breaking, and in double plowing, as above described, the additional cost averages \$1.25 per acre. These costs are somewhat less when a 10-inch depth of plowing has become the rule upon a given field. There is no question that breaking and pulverizing to a depth of 8 to 10 or 12 inches and adding plenty of humus is economical. Whether a plant has plenty of food all the time or only part of the time makes the difference between a good crop and a poor crop.

IS IT ADVISABLE TO PLOW DEEPER THAN 8, 10, OR 12 INCHES?

The depth of plowing must be determined by the farmer himself. He knows the conditions and is the best judge of the cost. In many sections, if done in the fall, it undoubtedly pays to subsoil 15 or 20 inches. This has been proved by some of the best farmers and experimenters in the world. Some subsoils in humid climates have been made so close and compact by the abundant rainfall that air does not penetrate them to aid in preparing plant food. Such fields, therefore, may not show any benefits of subsoiling until after two or more years.

It rarely pays to subsoil land in the spring, and it is never advisable to use the subsoil plow when the subsoil is fully saturated with water, even though the surface be fairly dry. Under such conditions of plowing the clay subsoil is pressed and packed, when the object is to pulverize it and allow the air to act upon it.

EXPERIENCE AGREES WITH THEORY.

No principle in agriculture has been more thoroughly demonstrated than the value of a deep, thoroughly pulverized seed bed.

The Romans plowed on an average 9 inches deep—always three times for a crop, and in stiff lands nine times. They did not call 3 inches “plowing;” it was only “scarifying.”

The Flemish farmers were the first to follow the better lines of agriculture after the dark ages. They devoted their efforts to three main points: (1) The frequent and deep pulverization of the soil, (2) the accumulation of manure, and (3) the destruction of weeds.

A deeper and more thoroughly pulverized seed bed was the foundation upon which England built an improved agriculture, and this principle has been generally accepted there for more than one hundred and sixty years, until the average production has increased nearly fivefold.

A late letter from Hon. William Saunders, director of the Central Experimental Farm, Ottawa, Canada, states that farmers usually plow shallowly immediately after harvest (August) “to preserve moisture and destroy weeds. * * * In October they commonly plow 8 inches deep. Any plowing done in the spring months is usually shallow, not more than 6 inches deep.” Eight inches of breaking in October in Canada, where frosts penetrate 3 or 4 feet deep, is better for moisture storage than plowing to a depth of 15 inches in the Southern States.

The directors of all southern experiment stations visited in recent years favor a deep and thoroughly prepared seed bed.

The Georgia Experiment Station bulletins repeatedly urge a deep, mellow, and rich seed bed for corn; and they insist that if the soil is not naturally such, it should be made so by tillage and the addition of humus. Bulletin No. 63 of the Georgia station, on “Cotton,” states that “fourteen years of experimentation have justified certain conclusions that may be accepted as practically final.” The following is one of them: “Thorough breaking and commingling of the upper soil, gradually increasing the depth to 8 or 10 inches, using plow and harrow, is more effective than deeper but less thorough pulverizing.”

The North Carolina bulletin issued February, 1905, states: “It unquestionably pays well to thoroughly break and broadcast-harrow land for corn. Using a 2-horse plow and running it 8 to 10 inches deep and afterwards harrowing with a large smoothing harrow puts the land in nice condition.”

On the sugar plantations of Louisiana the tillage for cane averages 12 to 15 inches in depth. On the Ewa plantation, in the Hawaiian Islands, the average depth of plowing is 30 inches. This plantation produces the largest crops of sugar cane to the acre in the world.

Nature's plan of improving soils is to use a cover crop of weeds, grass, shrubs, or trees and to subsoil by sending the roots down 1, 2, 3, or 4 feet, as the case may be, thus airing and enriching the subsoil without bringing it to the surface.

In the Farmers' Cooperative Demonstration Work the importance of a deep and thoroughly prepared seed bed, like a garden, has been most widely demonstrated. Thousands of tests have been made each year by exact and painstaking farmers to an extent that leaves no possible room for doubt as to the great value of a deep and thoroughly prepared seed bed.

Concretely stated, a deep, thoroughly pulverized seed bed filled with humus has the following advantages:

(1) It provides more food, because it increases chemical action and multiplies bacterial life in a larger body of soil.

(2) It stores more moisture and it loses its moisture less rapidly on account of its cooler lower strata and the presence of more humus.

(3) It increases the number and length of roots that a plant will throw out.

(4) It allows plants to root deeper and find permanent moisture.

(5) It largely obviates the necessity of terracing, because it holds so much water in suspension that heavy rainfalls will go to the bottom and be held by the drier earth above until they can be absorbed by the subsoil.

(6) Humus enables the soil to store more moisture, increases its temperature, makes it more porous, furnishes plant food, stimulates chemical action, and fosters bacterial life.

EXCEPTIONS TO GENERAL RULES FOR DEEP FALL PLOWING.

(1) Never plow below the line of standing water in the soil, because the subsoil can not be pulverized in water. The water level must first be lowered by drainage.

(2) Do no deep fall plowing on deep, light sandy land, and this especially applies to elevated sandy table-lands which drift in windy weather. Such lands can be helped by adding humus and, except in semiarid regions, by using a winter cover crop.

(3) The object of deep fall plowing is mainly to increase the supply of plant food and the storage of moisture in the soil. While this preparation is of great value on rolling lands and in nearly all fields so long in cultivation that plant growth is medium or less, there are some soils that for the production of cotton better not be deep fall broken, such as very rich and moist river bottoms and the virgin black-land prairies of the Gulf States, for the evident reason that

too much plant food for cotton is already available in the soil, with abundant moisture—conditions that make for an excessive growth of the cotton stalks and a consequent decrease in fruitage—even under ordinary conditions. For the cotton crop upon such lands it is better to plow very shallow in the spring and bed upon the firm soil.

(4) Do not plow deeply or subsoil in the spring. The subsoil is generally too full of water, and it is too late for much effective action of the air upon the soil and for the winter rains to firm the subsoil before planting cotton.

(5) Where the land is level, with a stiff subsoil, it should be broken into ridges from 5 to 10 feet wide with deep water furrows having a good outlet for drainage. On the gray post-oak flats, stiff bottom, and coast lands this practice should be followed. This will give drainage, reduce washing, and deepen the loose soil so that air and warmth may better do their work of preparation for plant growth.

In using the ridge method, the plants may be left thicker in the drill when desirable. The object of the 10-foot beds is to allow two rows instead of one to be drained by a single furrow. This double-row plan has proved very satisfactory, especially on bottom lands. Many good farmers on hill lands have adopted it with success. On the hill soils it not only furnishes greater protection in case of heavy rains, but also allows much more undisturbed space for root growth and for holding moisture in case of drought. The early cultivation can be done so as to maintain the ridge effect for possible drainage, and by the end of the season the beds will have been worked down to almost level.

The sugar planters of Louisiana use the ridge method (7-foot rows) for both sugar cane and corn. The dead furrows are as deep as four to six mules can draw the plow—frequently 12 to 15 inches.

The adoption of the ridge method in the Yazoo Delta has increased the corn yield from 14 bushels per acre to 70 bushels, without the use of commercial fertilizer.

WINTER MANAGEMENT.

In case no winter cover crop is used the level land should be disked or harrowed two or three times during the winter, provided it is dry enough. Give good drainage to all parts of the field.

Any cultivation done after the deep fall breaking should be shallow—not more than 3 or 4 inches deep.

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Approved:

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